= −0.053, NS). These results suggest that in post-infarction patients with reduced LVEF, heart rate variability is mainly determined by the sympathetic overdrive caused by the loss of left ventricular performance which masks the physiologic influence of age.

980-147 Anti-ischemic Efficacy of Beta-blockers in Effort Angina Patients is Correlated with Heart Rate Variability Change After Therapy

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Although it is reported that reduced heart rate variability (HRV) predicts poor prognosis in patients (pts) with coronary artery disease, little data is available about the effects of antianginal drugs on HRV. *The aim of this study is* to compare the effects of various antianginal drugs on autonomic nervous activity in pts with effort angina (EA) using ambulatory ECG monitoring (AEM) and analysis of HRV. Forty-four pts with EA (55 ± 9 years) were allocated to 3 treatment groups: (isosorbide dinitrate: 18 pts, diltiazem or nifedipine: 12 pts, and propranolol or metoprolol: 14 pts). AEM was performed before and after 2 week treatment.

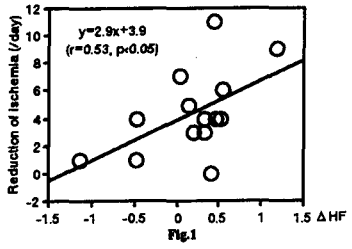

Fig.1

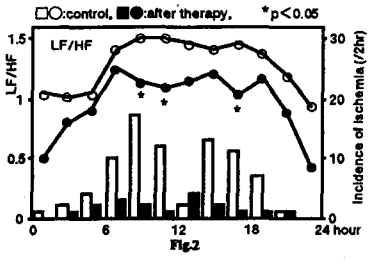

Fig.2

Results: Beta-blockers significantly decreased LF/HF and increased HF, and the degree of increase in HF (ΔHF) was significantly correlated with the reduction of ischemic attacks (Fig. 1). Also, beta-blockers abolished the morning peak of ischemic attacks, which was significantly related to suppression of LF/HF (Fig. 2). Nitrates and Ca-antagonists did not change any HRV parameters. *Conclusion:* Not only suppressed sympathetic tone but also augmented vagal tone may contribute to the antianginal effect of beta-blockers.

980-148 Effects of Various Antianginal Agents on Heart Rate Variability in Patients with Silent Myocardial Ischemia

B. Takase, H. Hikita, A. Uehata, T. Nagai, K. Isojima, A. Kurita, H. Nakamura. *Self Defense Force Central Hospital, Tokyo, Japan, National Defense Medical College, Saitama, Japan*

Heart rate variability indices (HRV) and silent myocardial ischemic episodes (SMI) can be used for prognostication of ischemic heart disease. To investigate the comparative effects of nipradilol (NP), carteolol (CL), diltiazem (DL) and bepridil (BP) on HRV and SMI, 59 patients (pts) with chronic stable angina underwent exercise treadmill testing (ETT) and 24 h ambulatory ECG monitoring (AECG) before (Pre) and after (Pst) medications; β-adrenergic blockers of NP (6 mg, ISA −) and CL (15 mg, ISA +) while calcium channel blockers of DL (90 mg) and BP (150 mg). BP has an additional class I-like antiarrhythmic action. All pts had SMI ≥ 1 (1 ≥ mm, 1 ≥ min, J 60 ms) in AECG. A single blind, 2-week placebo-controlled design was utilized, and pts were randomly allocated to each treatment arm; 16 pts (62 ± 8 years) in NP, 16 pts (61 ± 8 years) in CL, 15 pts (56 ± 6) in DL and 12 pts (66 ± 9 years) in BP. HRV from AECG included mean RR interval (RR, ms), SDANN (ms), SD (ms), rMSSD (ms), pNN50 (%) and frequency analysis of heart rate spectrum resulted in low (L, ms, 0.04–0.15 Hz) and high (H, ms, 0.15–0.40 Hz) frequency components. Results in table (Pre/Pst; SMI, n/24 h, median; others, mean; *, p < 0.05 vs Pre).

ETT	time(s)	SMI	RR	SDANN	SD	rMSSD	pNN50	L	H
NP	394/429*	2/0*	814/950*	119/123	42/49*	21/27*	4/7*	14/16	8/10*
CL	429/459*	2/0*	815/840*	117/ 81	43/40	23/22	5/4	16/15	9/ 9
DL	397/425*	2/0*	879/929*	140/139	48/47	23/27	5/6	15/15	9/10
BP	457/527*	2/0*	876/964*	140/133	49/50	24/30	5/7	15/16	9/11

All medications ameliorated ETT results and SMI and increased RR in AECG, whereas only NP increased HRV. *Conclusion:* Effects on HRV were different among antianginal agents even if anti-ischemic effects were identical. This should be considered in clinical practice.

981 Cardiac Pacing/Atrial Activation

Tuesday, March 18, 1997, 9:00 a.m.–11:00 a.m.
Anaheim Convention Center, Hall E
Presentation Hour: 10:00 a.m.–11:00 a.m.

981-137 Automatic and Efficient R-Wave and P-Wave Discrimination in Right Atrium Using a Two-State Hidden Markov Model

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Background: The current technique used in implantable devices of adjusting atrial refractory and atrial sensitivity to discriminate between far field R-waves (FFRW) and P-waves is limited. Reliable detection or rejection of FFRW in atrial electrograms would avoid some causes of inappropriate atrial sensing, thus improving DDD sensing and atrial arrhythmia detection. In addition, detection of FFRWs may be used as a measure for AV conduction time in atrial tracking modes and allow discrimination of supra-ventricular tachyarrhythmia from ventricular tachyarrhythmia in ICD patients. *Study Goal:* Evaluate a new technique – two-state hidden Markov model for R- and P-wave discrimination in atrium. *Methods:* Atrial and ventricular unipolar electrograms were collected from 25 patients undergoing pacemaker implant or replacement. Approximately 5 minutes of intrinsic electrograms were recorded and post-analyzed. A new two-state hidden Markov model was developed specifically for FFRW and P-wave discrimination in the atrium. The recorded patients' electrograms were analyzed using this model and the sensitivity and positive predictivity of FFRW detection were evaluated. The collected atrial electrograms were visually examined and marked as the control for verification of the detection analysis. *Results:* FFRW detection using this model had an overall sensitivity of 94.2 (± 9.4)% and a positive predictivity of 98.3 (± 4.4)%. While FFRW rejection using the same model had a sensitivity of 98.8 (± 3.8)% and a positive predictivity of 99.1 (± 1.7)%. *Conclusions:* FFRW and P-wave discrimination in right atrium by the two-state Hidden Markov model is reliable and accurate, and can significantly improve atrial arrhythmia management for pacemaker patients.

981-138 Prediction of Atrial Fibrillation Following Pacemaker Implantation: Use of the Electrophysiological Evaluation

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Previous studies have concluded that non-physiological pacing (VVI) more often promotes the development of atrial fibrillation (AF) than does physiological pacing (AAI/DDD). However, it remains unclear whether the electrophysiological (EP) parameters offer any additional predictive value. *Methods:* Thirty-eight patients (19 males and 19 females, mean age 68 ± 11 (mean ± S.D.) years) with sick sinus syndrome (SSS) complicated with the paroxysmal atrial fibrillation (AF) were studied. We evaluated their atrial vulnerability by the EP examination. We defined that if the patients had repetitive atrial firing (RAF) or fractionated atrial activation (FAA) in the EP examination, their atrial vulnerability was positive (VULp), and if they had not both response, their atrial vulnerability was negative (VULn). After the EP evaluation, 11 patients were treated with VVI pacing and 27 were treated with DDD/AAI. None of the patients received any class I or III antiarrhythmic drugs. *Results:* The mean follow-up period was 2.9 ± 1.8 years. Overall, AF was documented in 17 patients (45%). The lowest incidence of AF was found in the VULn patients with DDD/AAI (19% vs. 64%, O.R. 7.6, p < 0.01). Considering other predictive factors (age, heart failure, structural heart disease), the EP evaluation was the most important predictor for the recurrence of AF in the patients with DDD/AAI (sensitivity 70% and specificity 77%.

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Conclusion: Similarly to the pacing mode, the EP evaluation offers highly important predictive value for the recurrence of AF after permanent pacemaker implantation.

981-139 Bachmann's Bundle Permanent Pacing Shortens Intra-Atrial Conduction Time. Will It Decrease Paroxysmal Atrial Fibrillation?

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It has been observed that patients with paroxysmal atrial fibrillation (PAF) tend to have broad, low-amplitude P waves. Investigators have demonstrated that bi-atrial pacing utilizing a more complex three lead system shortens intra-atrial conduction time and decreases the incidence of PAF. Preliminary studies with temporary leads has suggested that Bachmann's Bundle pacing (BBP) at the superior aspect of the intra-atrial septum could accomplish the same shortening of P wave duration using one atrial lead. No studies with permanent pacing leads have been reported to date.

We evaluated 21 consecutive pts. (12 M/9 F), age 52–89 yr. (mean 73) with uncontrollable PAF referred for AV nodal ablation and permanent pacing. Permanent BBP was performed using bipolar, active-fixation leads. P wave durations were measured in lead II at 100 mm/sec paper speed, at baseline in sinus rhythm (NSR) and with BBP. The leads were left in the Bachmann's Bundle region in all patients and dual-chamber pacemakers with mode-switching capabilities were implanted. Analysis was done using a paired *t*-test and results are expressed as mean ± SD below. A p-value of <0.05 was considered significant.

NSR (msec)	BBP (msec)	p value	Sensing (P waves)	Threshold
162.6 ± 18.7	133.2 ± 16.1	p < 0.0001	2.2 mV (1.2–6.0)	1.3 V (0.5–2.2)

No complications related to lead placements were seen in follow-up.

Conclusions: 1) BBP is feasible, safe, and can decrease atrial conduction times using existing lead and pacemaker technology. 2) A randomized, controlled trial is needed to evaluate the efficacy of BBP in decreasing PAF.

981-140 Regional Atrial Conduction Delays Vary for Short Coupled Premature Beats During Single and Dual Site Atrial Pacing

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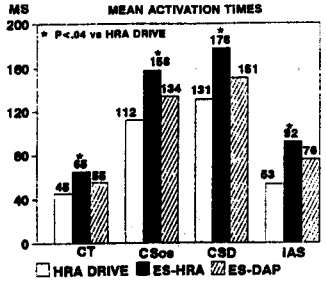
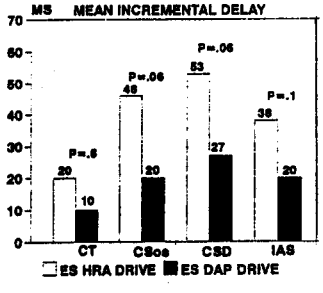
We examined regional atrial activation patterns of closely coupled atrial premature beats [APBs] using extrastimuli during programmed atrial stimulation in 10 pts with atrial fibrillation or tachycardia. Sites mapped included crista terminalis [CT], right AV junction, interatrial septum [IAS], coronary sinus [CS] os, distal CS [CSD] & superior LA. Mean activation times were measured during high RA pacing & for high right APBs coupled at 250 ms during high RA & dual site (high RA + CSos) atrial pacing [DAP]. Incremental delay at mapped sites for APBs during high RA pacing & DAP was compared.





APBs during high RA pacing significantly prolonged regional activation times ($p < 0.05$) while APBs during DAP did not ($p > 0.2$). Mean incremental delay was most pronounced for APBs at the IAS, CSos & CSD & was greater than the CT ($p < 0.05$ vs CSos & CSD & $p = 0.1$ vs IAS). *Conclusions:* 1) Closely coupled APBs encounter greater regional conduction delay at the IAS, CSos & CSD. 2) This incremental conduction delay is less pronounced during DAP.

981-141 Comparison of Right Atrial Activation During Coronary Sinus Ostial Pacing With Dual Site Right Atrial and Biatrial Pacing

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Dual site pacing modes advance RA activation in comparison to high RA pacing but have not been compared to coronary sinus ostial [CSos] pacing. We compared, in terms of global & regional atrial activation times, CSos pacing to biatrial [BAP] & dual site RA [DAP] pacing in 12 pts with spontaneous atrial arrhythmias undergoing electrophysiologic testing. Activation times were measured during pacing drive at 600 ms (n = 10), & for extrastimuli [ES] at the high RA coupled at 350 ms (n = 7). Recording sites were crista terminalis [CT], interatrial septum [IAS], His bundle [HB], distal CS.

Results:

	CT		IAS		P wave	
DAP	35 ± 12	p < 0.001	40 ± 13	p = 0.001	103 ± 15	p < 0.01
CSos	101 ± 19	p < 0.001	65 ± 14	p < 0.01	137 ± 27	p > 0.15
BAP	37 ± 15		43 ± 16		122 ± 18	

For ES delivered at the high RA, P wave duration tended to be longer at the CSos (218 ± 35 ms) versus DAP (177 ± 35 ms, $p = 0.08$) & BAP (170 ± 43 ms, $p = 0.1$). However, activation time at CT & IAS did not show significant differences.

Conclusions: 1) CSos pacing prolongs global atrial activation in comparison to dual site pacing modes. 2) CT & IAS activation is achieved earlier in dual site pacing modes as compared to CSos pacing. 3) Propagation of ES from the high RA tends to be delayed after CSos pacing as compared to DAP & BAP but this delay is not localized to the CT or IAS.

982 Basic Electrophysiology of Supraventricular Arrhythmias

Tuesday, March 18, 1997, 9:00 a.m.–11:00 a.m.
Anaheim Convention Center, Hall E
Presentation Hour: 9:00 a.m.–10:00 a.m.

982-116 Epicardial Maps in a Canine Model of Chronic Atrial Fibrillation After Linear Ablation Lesions

H.J. Sih, E.J. Berbari, D.P. Zipes. *Indiana University/Purdue University, Indianapolis, IN, USA*

The purpose of this study was to record epicardial maps in open-chest dogs during radiofrequency ablation of chronic atrial fibrillation (AF) to investigate how atrial lesions eliminate AF. Self-sustained AF was created in six dogs (23 ± 5 kg) by long-term (>4 weeks), rapid atrial pacing. We ablated the epicardium circumferentially around the right and left atrial appendages, superiorly from the left to the right atrium, from mid-SVC to the right atrial appendage, from SVC to IVC, and endocardially in the coronary sinus. Four second epicardial maps from the left and right atrial free walls were obtained using an 8 × 14 array of unipolar electrodes (2 × 4 cm) before and after creating each lesion. In 4 dogs, AF was eliminated after creating all 6 lesions. In the other 2 dogs, AF was eliminated after creating 5 lesions. In one of these dogs, short runs of AF could then be induced by rapid pacing, while in the other dog only short runs of atrial flutter could be induced. During AF, patterns of activation were complex with multiple wavelets. Conduction velocity and the number and size of wavelets did not change in either the left or right free wall with the number of lesions. Median fibrillatory cycle length increased with the number of lesions and was always shorter in the left atrium than in the right ($p < 0.0001$). When comparing AF with no lesions to AF just prior to its elimination, the median fibrillatory cycle length in the left atrium increased from 76 ± 18 ms to 110 ± 38 ms ($p < 0.02$) and in the right atrium from 104 ± 22 ms to 151 ± 32 ms ($p < 0.001$). In conclusion, elimination of AF by linear lesions results in increases in cycle length of AF without changes in conduction velocity, number or size of wavelets, or complexity of activation patterns during AF, perhaps due to decreasing effective atrial mass.